



Hands-Free Transcranial Color Doppler Probe

These probes enable full use of TCD technology for neurological diagnostics.

Lyndon B. Johnson Space Center, Houston, Texas

Current transcranial color Doppler (TCD) transducer probes are bulky and difficult to move in tiny increments to search and optimize TCD signals. This invention provides miniature motions of a TCD transducer probe to optimize TCD signals.

The mechanical probe uses a spherical bearing in guiding and locating the tilting crystal face. The lateral motion of the crystal face as it tilts across the full range of motion was achieved by minimizing the distance between the pivot location and the crystal face. The smallest commonly available metal spherical bearing was used with an outer diameter of 12 mm, a 3-mm tall retaining ring, and 5-mm overall height. Small geared motors were used that would provide sufficient power in a very compact package. After confirming the validity of the basic positioning concept, optimization design loops were completed to yield the final design.

A parallel motor configuration was used to minimize the amount of space wasted inside the probe case while minimizing the overall case dimensions. The distance from the front edge of the crys-

tal to the edge of the case was also minimized to allow positioning of the probe very close to the ear on the temporal lobe. The mechanical probe is able to achieve a $\pm 20^\circ$ tip and tilt with smooth repeatable action in a very compact package. The enclosed probe is about 7 cm long, 4 cm wide, and 1.8 cm tall.

The device is compact, hands-free, and can be adjusted via an innovative touchscreen. Positioning of the probe to the head is performed via conventional transducer gels and pillows. This device is amendable to having advanced software, which could intelligently focus and optimize the TCD signal.

The first effort will be development of monitoring systems for space use and field deployment. The need for long-lived, inexpensive clinical diagnostic instruments for military applications is substantial. Potential future uses of this system by NASA and other commercial end-users include monitoring cerebral blood flow of ambulatory patients, prognostic of potential for embolic stroke, ultrasonic blood clot treatment, monitoring open-heart and carotid end-

arterectomy surgery, and resolution of the controversy regarding transient ischemic attacks and emboli's role. Monitoring applications include those for embolism formation during diving ascents, changes in CBFV (cerebral blood flow velocity) in relation to cognitive function as associated with sick building syndrome or exposure to environmental and workplace toxins, changes of CBFV for testing and evaluating Gulf War Syndrome, and patients or subjects while moving or performing tasks.

This work was done by Robert Chin of Gen-eXpress Informatics, and Srihdar Madala and Graham Sattler of Indus Instruments for Johnson Space Center. Further information is contained in a TSP (see page 1).

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to:

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Refer to MSC-24702-1, volume and number of this NASA Tech Briefs issue, and the page number.

Improving Balance Function Using Low Levels of Electrical Stimulation of the Balance Organs

A device based on this technology may be used as a miniature patch worn by people with disabilities to improve posture and locomotion, and to enhance adaptability or skill acquisition.

Lyndon B. Johnson Space Center, Houston, Texas

Crewmembers returning from long-duration space flight face significant challenges due to the microgravity-induced inappropriate adaptations in balance/sensorimotor function. The Neuroscience Laboratory at JSC is developing a method based on stochastic resonance to enhance the brain's ability to detect signals from the balance organs of the inner ear and use them for rapid improvement in balance skill, especially when combined with balance training exercises. This method involves a stimulus delivery system that is

wearable/portable providing imperceptible electrical stimulation to the balance organs of the human body.

Stochastic resonance (SR) is a phenomenon whereby the response of a nonlinear system to a weak periodic input signal is optimized by the presence of a particular non-zero level of noise. This phenomenon of SR is based on the concept of maximizing the flow of information through a system by a non-zero level of noise. Application of imperceptible SR noise coupled with sensory input in hu-

mans has been shown to improve motor, cardiovascular, visual, hearing, and balance functions. SR increases contrast sensitivity and luminance detection; lowers the absolute threshold for tone detection in normal hearing individuals; improves homeostatic function in the human blood pressure regulatory system; improves noise-enhanced muscle spindle function; and improves detection of weak tactile stimuli using mechanical or electrical stimulation. SR noise has been shown to improve postural control when applied

as mechanical noise to the soles of the feet, or when applied as electrical noise at the knee and to the back muscles.

SR using imperceptible stochastic electrical stimulation of the vestibular system (stochastic vestibular stimulation, SVS) applied to normal subjects has shown to improve the degree of association between the weak input periodic signals introduced via venous blood pressure receptors and the heart-rate responses. Also, application of SVS over 24 hours improves the long-term heart-rate dynamics and motor responsiveness as

indicated by daytime trunk activity measurements in patients with multi-system atrophy, Parkinson's disease, or both, including patients who were unresponsive to standard therapy for Parkinson's disease. Recent studies conducted at the NASA JSC Neurosciences Laboratories showed that imperceptible SVS, when applied to normal, young, healthy subjects, leads to significantly improved balance performance during postural disturbances on unstable compliant surfaces. These studies have shown the benefit of SR noise characteristic opti-

mization with imperceptible SVS in the frequency range of 0–30 Hz, and amplitudes of stimulation have ranged from 100 to 400 microamperes.

This work was done by Jacob Bloomberg and Millard Reschke of Johnson Space Center; Ajitkumar Mulavara and Scott Wood of USRA; Jorge Serrador of Dept. of Veterans Affairs NJ Healthcare System; Matthew Fiedler, Igor Kofman, and Brian T. Peters of Wyle; and Helen Cohen of Baylor College. For further information, contact the JSC Innovation Partnerships Office at (281) 483-3809. MSC-25013-1

Developing Physiologic Models for Emergency Medical Procedures Under Microgravity

Lyndon B. Johnson Space Center, Houston, Texas

Several technological enhancements have been made to METI's commercial Emergency Care Simulator (ECS) with regard to how microgravity affects human physiology. The ECS uses both a software-only lung simulation, and an integrated mannequin lung that uses a physical lung bag for creating chest excursions, and a digital simulation of lung mechanics and gas exchange. METI's patient simulators incorporate models

of human physiology that simulate lung and chest wall mechanics, as well as pulmonary gas exchange.

Microgravity affects how O₂ and CO₂ are exchanged in the lungs. Procedures were also developed to take into account the Glasgow Coma Scale for determining levels of consciousness by varying the ECS eye-blinking function to partially indicate the level of consciousness of the patient. In addition, the ECS was modi-

fied to provide various levels of pulses from weak and thready to hyper-dynamic to assist in assessing patient conditions from the femoral, carotid, brachial, and pedal pulse locations.

This work was done by Nigel Parker and Veronica O'Quinn of Medical Education Tech, Inc. for Johnson Space Center. Further information is contained in a TSP (see page 1). MSC-23922-1

PMA-Linked Fluorescence for Rapid Detection of Viable Bacterial Endospores

This method has applications in the pharmaceutical, food microbiology, semiconductor, and other industries requiring surface sterilization.

NASA's Jet Propulsion Laboratory, Pasadena, California

The most common approach for assessing the abundance of viable bacterial endospores is the culture-based plating method. However, culture-based approaches are heavily biased and oftentimes incompatible with upstream sample processing strategies, which make viable cells/spores uncultivable. This shortcoming highlights the need for rapid molecular diagnostic tools to assess more accurately the abundance of viable spacecraft-associated microbiota, perhaps most importantly bacterial endospores.

Propidium monoazide (PMA) has received a great deal of attention due to its ability to differentiate live, viable

bacterial cells from dead ones. PMA gains access to the DNA of dead cells through compromised membranes. Once inside the cell, it intercalates and eventually covalently bonds with the double-helix structures upon photoactivation with visible light. The covalently bound DNA is significantly altered, and unavailable to downstream molecular-based manipulations and analyses. Microbiological samples can be treated with appropriate concentrations of PMA and exposed to visible light prior to undergoing total genomic DNA extraction, resulting in an extract comprised solely of DNA arising from viable cells. This ability to extract DNA

selectively from living cells is extremely powerful, and bears great relevance to many microbiological arenas.

While this PMA-based selective chemistry has been applied to several polymerase chain reaction (PCR)-based molecular protocols, it has never been coupled with fluorescence *in situ* hybridization (FISH)-based microscopic methods. FISH microscopy is a powerful technique for visualizing and enumerating microorganisms present in a given sample, which relies on the ability of fluorescently labeled oligonucleotide probes to gain access to, and hybridize with, specific nucleic acid sequences within cells. Dogmatic princi-